

Message Text

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TAGS: ESTC, COCOM, US, UR

SUBJECT: US EPITAXIAL REACTORS FOR THE MANUFACTURE OF LIGHT
EMITTING DIODES TO THE USSR--IL 1355

REF: A) PARIS 11518, B) COCOM DOC (77) 887

1. THE REFERENCED TELEGRAM CONTAINS ADDITIONAL QUESTIONS
ASKED OF US IN COCOM BY THE GERMAN AUTHORITIES ON APRIL 5,
1978. THESE QUESTIONS, WHEN RECEIVED IN WASHINGTON, WAS
FORWARDED TO THE U.S. APPLICANT, APPLIED MATERIALS, INC.,
BY THE STATE DEPARTMENT. IN TURN, APPLIED MATERIALS HAS -
GIVEN OEA THEIR TECHNICAL RESPONSES OF EACH OF THE
QUESTIONS RAISED. THIS TECHNICAL INPUT ANSWERS ALL THE
GERMAN ISSUES SAVE, PERHAPS, THE AREAS OF TECHNOLOGY
TRANSFER AND SOVIET CAPABILITY. WE RECOMMEND USE OF THE
ANSWERS PROVIDED BY APPLIED MATERIALS.
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2. IN THE OPINION OF COMMERCE TECHNICIANS, THERE IS VERY
LITTLE RISK THAT KNOW-HOW FOR THE MANUFACTURE OF STRATE-
GIC MICROWAVE DEVICES CAN ACCOMPANY THE EXPORT OF THE AMG
500 REACTORS. CLEARLY, THE SOVIETS DO HAVE MILITARY NEEDS
FOR MICROWAVE SEMICONDUCTORS, BUT THE AMG 500 CANNOT AID
THE SOVIET EFFORT TO SUPPLY THESE NEEDS. THESE REACTORS
AS CONSTRUCTED WILL ONLY PROCESS LED MATERIAL, AND NO
KNOWN MANUFACTURER HAS USED OR EVEN HAS CONSIDERED
USING THE AMG 500 FOR MICROWAVE MATERIAL. THE AMG 500 IS
NOT AND HAS NOT BEEN DESIGNED FOR FABRICATING THE HIGH

PURITY LAYERS AND/OR THE ABRUPT LAYER TRANSITIONS REQUIRED FOR STRATEGIC DEVICES. HOWEVER, IN THE EVENT THAT MACHINE MODIFICATIONS WERE ATTEMPTED (PRESUMING SOVIET DESIGN CAPABILITY) THE COMPANY SERVICE TECHNICIANS WOULD DETECT SUCH ALTERATIONS; AND, IN SUCH AN EVENT, THE MATTER WOULD BE REPORTED TO THE U.S. GOVERNMENT WITH EQUIPMENT SERVICING IMMEDIATELY BEING DISCONTINUED. CONSIDERABLE SERVICE ATTENTION IS NECESSARY, SINCE THESE REACTORS CEASE TO FUNCTION PROPERLY, EVEN FOR PREPARING THE WIDE TOLERANCE LED MATERIALS, IN A MATTER OF MONTHS AND, THEREBY, BECOME USELESS THROUGH PERFORMANCE DETERIORATION.

3. THERE IS LITTLE EVIDENCE OF SOVIET INTEREST IN PURCHASING EPITAXIAL REACTORS, IF JUDGED BY THE LACK OF COMMERCIAL CONTACTS AND COCOM EXCEPTIONS PRESENTED. THERE HAS BEEN JUST LITTLE OR NO TRAFFIC IN THIS COMMODITY IN RECENT YEARS.

4. FOLLOWING ARE REPLIES TO GERMAN QUESTIONS GIVEN BY COMPANY:

A) THE ARGUMENTS WE GIVEN AGAINST CONVERSION OF LED
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REACTORS INTO SILICON EPITAXIAL REACTORS. IF THE PROBLEM IS ECONOMIC WHAT IS TO PREVENT THE RUSSIANS FROM DOING IT ANYWAY?

ANSWER: WE DO NOT BELIEVE THAT THE ANSWER WE SUPPLIED WAS JUST ECONOMICS. THERE ARE SERIOUS TECHNOLOGICAL REASONS WHY AN AMG-500 CANNOT BE CONVERTED TO A SILICON EPITAXIAL REACTOR. FIRST, AN AMG-500 REACTOR. THE OPERATIONAL TEMPERATURE OF THE AMG500 REACTOR IS MANY HUNDREDS OF DEGREES LOWER THAN A SILICON EPI REACTOR. THE RF COIL DESIGN IS INCORRECT AND THE POWER SUPPLY IS UNDERPOWERED FOR SILICON EXPITAXY. ANOTHER MAJOR OBJECTION IS THAT THE AMG-500 GAS PANEL IS SET UP FOR LED PROCESSING. SILICON EPI REQUIRES A COMPLETELY DIFFERENT GAS PANEL WITH DIFFERENT DOPANT GAS DILUTION AND MIXING AND DIFFERENT SOURCE GASES. WE CAN THINK OF VERY LITTLE THAT CAN BE SALVAGED IF WE WERE TO CONVERT EXCEPT STANDARD VALVES AND COMPONENTS WHICH ARE AVAILABLE THROUGHOUT THE WORLD BUT REQUIRE THE KNOWLEDGE TO ASSEMBLE THEM.

THE AMG-500 REACTOR CHAMBER USES A MULTIPLE GAS INLET ARRANGEMENT INCLUDING HCl TO A GALLIUM SOURCE, PH₃/ASH₃/ DOPANT TO A PREMIX ZONE AND DUAL HYDROGEN INLETS TO A REACTOR CHAMBER PURGE AND AN EXHAUST PURGE. A SILICON EPITAXIAL REACTOR USES A SINGLE INLET. TO CHANGE THE AMG-500 TO THE CONFIGURATION WOULD BE SIGNIFICANT.

IN CONCLUSION CONVERSION OF A AMG-500 WOULD BE TECHNICALLY

VERY DIFFICULT AND ECONOMICALLY UNFEASIBLE.

B) OF WHAT IMPORTANCE IS THE TRANSFER OF STRATEGIC PRODUCTION?

ANSWER: THE AMG-500 AND THE AMG-500C WERE DESIGNED ONLY FOR PRODUCING LED'S. THERE IS NO KNOWN MANUFACTURER WHO HAS USED OR HAS CONSIDERED USING THE AMG-500 FOR CONFIDENTIAL

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MICRO-WAVE MATERIAL. IT IS ENTIRELY THE WRONG DESIGN. REQUIRED PURITY LEVELS CANNOT BE OBTAINED.

PRODUCTION KNOWHOW ON LED'S AND BASIC MICROWAVE DEVICES HAVE BEEN WIDELY PUBLISHED THROUGH THE WORLD.

REFERENCE: PIGHINI-GREENE PAPER; PUBLISHED MARCH 1969, "LARGE AREA EPITAXIAL GROWTH GAAS (I-X)PX FOR DISPLAY APPLICATIONS."

-- BYRD PAPER ISSUED MARCH 1969, "MULTI WAFER GROWTH SYSTEM FOR EPITAXIAL DEPOSITION OF GAAS AND GAAS 1-XPX

-- MICROWAVE TECHNOLOGY PUBLISHED IN FUJIKAU LABORATORIES PAPER AUGUST 1976, "GA-ASC18 SYSTEM DEFINED, INTERNATIONAL ELECTROCHEM PAPER

-- NIPPON ELECTRIC PAPER ON MULTILAYER EPI TECHNOLOGY FOR THE SCHOTTKY BARRIER GAAS FET'S, PUBLISHED INTERNATIONAL PHYSICS SCIENCE CONFERENCE 1975 OUTLINES ASCI3 LIQUID PHASE PROCESS.

- EPITAXIAL REACTOR FOR GAAS-P FILMS; ROSLER AND BENZING, APPLIED MATERIALS, INC., PUBLISHED IN INTERNATIONAL CVD CONFERENCE APRIL 1972.

TRANSFER OF PRODUCTION KNOWHOW WOULD BE SOLELY LIMITED BY LED PRODUCTION.

C) WHAT IS THE EXTENT OF TECHNICAL KNOWHOW TRANSFERRED INCLUDING ANY KNOWHOW TRANSMITTED ON THE SPOT BY MAINTENANCE SPECIALISTS? CONFIDENTIAL

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ANSWER: OUR FIELD SERVICE ENGINEERS ARE NOT TECHNOLOGISTS. THEY HAVE BEEN TRAINED TO START AND OPERATE EQUIPMENT TO A GIVEN SPECIFICATION.

D) DOES THE SOVIET UNION HAVE SUFFICIENT SILICON EPITAXIAL REACTOR CAPABILITY OF THEIR OWN PRODUCTION?

ANSWER: TO OUR KNOWLEDGE THE EAST BLOCK HAS NOT HAD AN INTEREST IN OBTAINING EPITAXIAL REACTORS FROM THE WESTERN WORLD. WE DO KNOW THAT THE RUSSIANS HAVE DEVELOPED THEIR OWN EPI REACTORS. WE HAVE SEEN PHOTOS AND SPECIFICATIONS OF THIS EQUIPMENT. THE REACTORS ARE VERY SIMILAR TO THE TYPES AVAILABLE IN THE WESTERN WORLD TODAY. THIS DESIGN IS 18 YEARS OLD AND HAS BEEN PUBLISHED AND DISCUSSED IN THE INTERNATIONAL CVD CONFERENCES.

SILICON WAFERS HAVE BEEN READILY AVAILABLE FOR SOMETIME TO THE EAST BLOCK FROM SEVERAL WESTERN SUPPLIERS.

E) TO WHAT EXTENT IS THE MANUFACTURE OR NON-MANUFACTURE OF MICROWAVE DEVICES ALSO VALID FOR VARACTOR DIODES, JUNCTION LASERS, SENSORY ELEMENTS FOR GUIDED WEAPONS, DELAY LINES, AND INFRARED DETECTOR?

ANSWER: MICROWAVE DEVICES SUCH AS VARACTOR DIODES, JUNCTION LASERS, AND OTHER MICROWAVE GALLIUM DEVICES REQUIRE MUCH SHARPER JUNCTIONS AND HIGHER PURITY THAN COULD EVER BE OBTAINED IN THE AMG-500'S. THIS HAS BEEN CONFIRMED BY A NUMBER OF MICROWAVE MANUFACTURERS IN THE U.S.

AVANTEK
HUGHES
MICROWAVE ASSOCIATES
TRW, AND OTHERS.

INFRARED DETECTORS ARE NOT GENERALLY MADE FROM GALLIUM
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ARSENIDE EPITAXIAL WAFERS. THE EFFICIENCY IS TOO LOW AND THEY ARE THE WRONG BAND GAP. STATE-OF-THE-ART DEVICES ARE MADE FROM OTHER COMPOUND SEMICONDUCTORS, TYPICALLY OF THE GROUP II-VI TYPE.

GALLIUM ARSENIDE IS THE WRONG MATERIAL FOR DELAY LINES. THE AMG-500 IS UNSUITABLE FOR DEPOSITING MATERIALS THAT COULD BE USED FOR DELAY LINES SUCH AS ZNO.

F) WHAT ARE THE REASONS WHICH JUSTIFY THE NEED FOR 3 REACTORS AND THE RELATION OF 2 AMG-500 REACTORS TO 1 AMG-500C REACTOR?

ANSWER: THE AMG-500 IS DESIGNED TO PRODUCE STANDARD RED DISPLAYS, THE TYPE OF DISPLAYS IN WIDEST USE. THE AMG-500-C IS DESIGNED TO PRODUCE YELLOW, GREEN AND AMBER DISPLAYS. MOST LED MANUFACTURERS IN THE U.S. HAVE MANY LED REACTORS. THREE REACTORS WOULD BE A VERY SMALL PRODUCTION FACILITY. WE WOULD EXPECT A SERIOUS MANUFACTURER TO HAVE 20-30 REACTORS.

G) IS IT POSSIBLE TO PRODUCE WITH THESE REACTORS BASIC MATERIAL FOR INFRARED DIODES AND/OR MATERIAL FOR LED'S WITH COHERENT LIGHT AND IF NOT WHY NOT?

ANSWER: ANSWERED ABOVE. PROBLEM AGAIN IS PURITY AND SHARP JUNCTIONS.

H) WHAT NUMBER OF LED'S IS TO BE PRODUCED ANNUALLY WITH THE THREE REACTORS?

ANSWER: THE AMG-500 IS CAPABLE OF PRODUCING 30,000 SQUARE INCHES OF LED MATERIAL PER YEAR (THREE RUNS PER 24 HOUR
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PERIOD, 50 SQUARE INCCHES PER RUN X 200 DAYS PER YEAR). NOTE: YIELD NOT FACTOR IN TOTAL. THE NUMBER OF 0.1 X 0.1 INCH DISPLAYS WOULD BE 3,000,000 AGAIN ASSUMING 1 0 PERCENT YIELD. THE TRUE OUTPUT IS PROBABLY ABOUT 1.5×10^{-6} DEVICES/YEAR/REACTOR.

I) FOR WHAT PERIOD OF TIME WILL THE MAINTENANCE CONTRACT BE CONCLUDED? ARE THE CONTROLS WHICH ARE TO BE CARRIED OUT EVERY SIX MONTHS STRUCTLY MANDATORY OR WILL THEY BE CARRIED WHENEVER THE CONSIGNEE HAS NEED FOR IT?

ANSWER: WE WOULD PROPOSE TO START THE EQUIPMENT AND DEMONSTRATE OPERATION TO A LED SPEC. BASED ON OUR EXPERIENCE WITH U.S. MANUFACTURERS, WE WOULD BELIEVE THE AMG-500 WOULD REQUIRE ATTENDANCE BY APPLIED MATERIALS' FIELD SERVICE ENGINEER EVERY 6-9 MONTHS IN ORDER TO REPLACE COMPONENTS. AS WE KNOW IN OPERATION CERTAIN COMPONENTS DEGRADATE AND EFFICIENCY IS A MUST IF THE EQUIPMENT IS TO BE MAINTAINED PROPERLY. MANY OF THE COMPONENTS AND DETAILED PARTS OF THE SYSTEM ARE MADE BY APPLIED MATERIALS. THE MATERIAL SELECTION IS IMPORTANT. DUPLICATING THIS BY AN OUTSIDE SOURCE COULD BE A PROBLEM.
CHRISTOPHER

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